

FOUR YEAR UNDERGRADUATE PROGRAM (2024 – 28)
DEPARTMENT OF PHYSICS
COURSE CURRICULUM

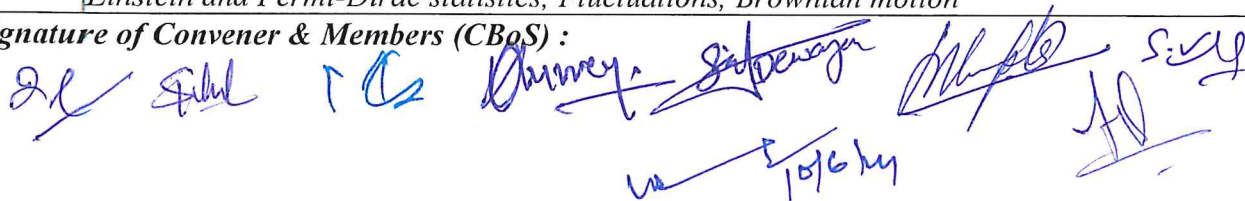
PART-A: INTRODUCTION			
Program: Bachelor in Science <i>(Honors/Honors with Research)</i>		Semester - VIII	Session: 2024-2025
1	Course Code	PHSE-11	
2	Course Title	Statistical Mechanics	
3	Course Type	Discipline Specific Elective	
4	Pre-requisite (if, any)	<i>As per Program</i>	
5	Course Learning Outcomes (CLO)	At the end of this course, the students will be able to: <ul style="list-style-type: none"> ➤ Explain the connection between statistics and thermodynamics. Define the phase space of the classical system. ➤ Define three different types of Ensembles and discuss corresponding theories. Define partition functions for different canonical systems. ➤ Explain energy, energy-density fluctuations, and correspondence of various ensembles. Explain statistics of different quantum mechanical ensembles. ➤ Discuss Bose-Einstein (BE) Condensate w.r.t. liquid Helium II, Define and discuss electron gas behavior w.r.t. Fermi Dirac Statistics ➤ Discuss Virial expansion of the equation of state. Discuss Brownian motion and Einstein and Smoluchowski theory 	
6	Credit Value	4 Credits	<i>Credit = 15 Hours - learning & Observation</i>
7	Total Marks	Max. Marks: 100	Min Passing Marks: 40

PART -B: CONTENT OF THE COURSE

Total No. of Teaching-learning Periods (01 Hr. per period) – 60 Periods (60 Hours)

Unit	Topics (Course Contents)	No. of Period
I	Foundation of Statistical Mechanics Macroscopic and microscopic states, contact between statistics and thermodynamics, physical significance of $\Omega(N, V, E)$, the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Liouville's theorem and its consequences, quantum states and phase space.	15
II	Elements of ensemble theory A system in microcanonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density Fluctuations and mutual correspondence of various ensembles	15
III	Formulation of quantum statistics Quantum mechanical ensemble theory, density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles. Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, Thermodynamic behavior of an ideal Fermi gas, the electron gas, non-relativistic and relativistic degenerate electron gas, theory of white dwarf stars.	15
IV	Statistical Mechanics of interacting systems The method of cluster expansion for a classical gas, Virial expansion of the equation of state. Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, Spatial correlation in a fluid Brownian motion: Einstein Smoluchowski's theory of Brownian motion	15
<i>Keywords</i>	<i>Macro and microstates, ensembles, phase space, partition function, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Fluctuations, Brownian motion</i>	

Signature of Convener & Members (CBoS) :



PART-C: LEARNING RESOURCES

Text Books, Reference Books and Others

Reference Books Recommended –

1. L. D. Landau & E. M. Lifshitz (Butter worth and Heinemann Press).
2. Federick Reif, Fundamental of statistical and thermal physics (McGraw-Hill publishers)
3. Kerson Huang, Statistical Mechanics (Wiley Eastern)
4. Charles Kittel, Elemental Statistical Physics

Text Books Recommended –

1. Brij Lal, N. Subrahmanyam, P S Hemne; Heat and Thermodynamics and Statistical Physics
2. R. K. Pathria, Statistical Mechanics (Pergamon Press)
3. Statistical and Thermal Physics an introduction; Michael J R Hoch

Online Resources– e-Resources / e-books and e-learning portals

1. Statistical Mechanics <https://archive.nptel.ac.in/courses/115/106/115106126/>
2. Introduction to Statistical Mechanics <https://archive.nptel.ac.in/courses/115/103/115103113/>
3. Statistical Mechanics <https://archive.nptel.ac.in/courses/115/106/115106111/>
4. Statistical mechanics <http://www.digimat.in/nptel/courses/video/115106126/L01.html>

PART -D: ASSESSMENT AND EVALUATION

Suggested Continuous Evaluation Methods:

Maximum Marks: 100 Marks

Continuous Internal Assessment(CIA): 30 Marks

EndSemester Exam(ESE): 70 Marks

Continuous Internal Assessment (CIA): (By Course Teacher)	Internal Test / Quiz-(2):	20 & 20	Better marks out of the two Test / Quiz + obtained marks in Assignment shall be considered against 30 Marks
	Assignment / Seminar - Total Marks -	10 30	
End Semester Exam (ESE):	Two section – A & B Section A: Q1. Objective – 10 x1= 10 Mark; Q2. Short answer type- 5x4 =20Marks Section B: Descriptive answer type qts., 1out of 2 from each unit-4x10=40 Marks		

Name and Signature of Convener & Members of CBoS:

